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THE TEA QUARTERLY

VOLUME XXIII JUNE, 1952 PART II

WASTAGE OF WORLD FOOD SUPPLIES THROUGH DISEASES AND PESTS

By

Sir John Russell

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The following address given by Sir John Russell opened the International Agricultural Conference held at the Fernhurst Research Station of Plant Protection Ltd., in June, 1951.

The address is such a well balanced account of the whole subject of plant pests and diseases that, in spite of its somewhat technical nature, it cannot fail to interest all those engaged in the production of tea in Ceylon.

From the earliest times cultivated crops have suffered from diseases and pests, but little could be done in the way of control till the causes were discovered. Plant Pathology was the latest to develop of all the sciences dealing with crop production : it is little more than 50 years old and even now there are great sections of it where our knowledge is very limited. The subject is of growing importance, because of the growing seriousness of the world food situation : India's recent food troubles, averted only by the rushing in of large quantities of grain grown by the Western peoples, show how grave the problem is. The steady expansion of the world's population, and the continuing loss of land due to natural causes like erosion and flooding, and to human activities such as the withdrawal of land from agriculture to put it to other purposes, continually make the problem more difficult. It is imperative that the wastes and losses due to diseases and pests should be reduced to a minimum. Where food is scarce it certainly cannot be spared for insects or fungi. Entomologists, mycologists and plant pathologists in this country and overseas have long emphasised the need for action, and now the Food and Agriculture Organisation of the United Nations has taken the matter up.

The losses caused by plant diseases and by weeds can only be estimated very approximately. Insect, fungus and bacterial populations are always with us and so long as their numbers remain small the damage they do is hardly perceptible except to an expert and so is disregarded. Plants make considerable provision for loss ; more tillers are produced by grain crops than can produce full sized heads, more blossom opens on fruit trees than can set good quality fruit. Destruction of some of these by pests does not necessarily lower the final yield. But there are always some losses, which, however, cannot be estimated because on any particular field the yields vary from year to year according to weather conditions and there is no fixed yard stick. A figure of 10 per cent is frequently quoted but it has no statistical basis and is really based only on guess work. A Plant Disease Survey has now been instituted under E. C. Large of the Ministry of Agriculture Plant Pathology

Laboratory, Harpenden, and more definite information may be expected. In countries of less advanced agriculture where the means of detecting and combating diseases are less effective the losses are almost certainly higher than here, and if ours are put at 10 it would probably not be unfair to put losses in many other countries at 20 or more per cent of a healthy crop. Estimates of this kind may be crude but they have a certain pragmatic value : expressed in money terms they look very impressive especially when as often happens, local scarcity prices are used, and they may induce hesitating Ministers to sanction activities that ought in any case to be undertaken. In another way too they are impressive : the losses as estimated are usually of the same order as the estimated shortage of food supplies, and it is probably true to say that the amount of food now destroyed in the field and in store by pests controllable on present knowledge would amply supply the world's present food deficits.

Physiological and Cultural Methods of Avoiding Diseases and Pests

Plant diseases fall roughly into two groups—physiological, due to deficiency or excess of some essential factor, and those caused by some pathogenic organism coming from outside. At present the physiological diseases attracting most attention are those due to deficiencies of the trace elements boron, copper, manganese, molybdenum and zinc. These eluded investigation till chemists had elaborated methods of working with the very minute quantities involved : agricultural science always has to limp behind pure science. Symptoms and methods of diagnosis and treatment are now being worked out : you are all familiar with Dr. Tom Wallace's publications from Long Ashton and W. A. Roach's work at East Malling. The diseases occur widely over the world : Australia has some striking examples.

The effect of pathogenic organisms on the plant depends in many instances on the conditions of growth : usually the organism can attack the plant only in one stage of its development, and the plant likewise is susceptible to attack only over a certain period of growth. Any cultivation or manurial device that throws plant and organism out of step protects against attack. Farmers at home have long since learned to sow oats early in order to avoid fritfly. H. F. Barnes at Rothamsted controlled gall midges on Meadow Foxtail grass by cutting back the grass a few weeks before flowering—the period of oviposition of the midges. This delayed flowering but not the midges. The two were put out of step and the damage was reduced from a former 90 per cent to 10 per cent.[1] Early maturing wheats are sought in Canada to avoid late rust, cotton in the Sudan is sown after the rains to avoid Black Arm.

The manuring of the crop affects its rate of growth and the structure and composition of the plant tissues : both are closely connected with susceptibility to attack. Much experimental work has been done at Rothamsted and elswhere to secure optimum physiological conditions for the crop, and this, combined with sound field sanitation—the destruction of infectious material—gives a large measure of protection even where there is a lively risk of infection. I have a vivid recollection of going round H. O. Larsen's glass houses in the Lea Valley and seeing his tomatoes and cucumbers beautifully sturdy and healthy while in the neighbourhood there were houses infested with a wide range of diseases. Cultural methods of dealing with two troublesome wheat diseases have been worked out, for Eyespot by M. D. Glynne, and for Take All by S. D. Garrett ; both depend on favouring the plant at the expense of the fungus. A particularly neat method was devised by an ingenious farmer F. P. Chamberlain of Benson, Oxfordshire, and put on a scientific basis by S. D. Garrett. The barley is undersown with trefoil and rye grass : this grows during the autumn and exhausts the available nitrogen in the soil so that the fungus is starved. In early spring the mixture is ploughed in and

[1]For fuller discussion of "Preventive Entomology" see C. B. Williams Annals Applied Biology, 1947, Vol. 34, pp. 175-185.

quickly decomposes, producing ammonia and nitrate in the soil that gives the next crop of barley such a good send off that it remains free from serious attack. In this way he has been able to grow at least twelve successive barley crops all healthy and yielding well.

In India mixed cropping has kept down certain soil diseases. R. S. Vasudeva[1] has collected a number of instances. In one trial cotton grown alone suffered to the extent of 52.5 per cent from root rot (*Rhizoctonia*), but when *Moth* (*Phaseolus aconitifolius*) was grown with it the mortality fell to 1.8 per cent. He attributed the effect to a lowering of the soil temperature.

The cultural methods of controlling disease will be greatly strengthened when it becomes possible to forecast the probability of a great increase in numbers of particular insects from a study of the preceding weather conditions such as C. B. Willinms has been doing[2]. Forecasting of the best dates for spraying has long been done for the fruit growers of South East England by Dr. A. M. Massee, based on field observations of the detailed fluctuations in the population of various pests, from week to week and month to month, in orchard and farm.

This undoubted connection between nutrition of the plant and its susceptibility to disease has been emphasised by the so-called Humus group, followers of the late Sir Albert Howard, who hold that organic material which has once lived is alone suitable as food for plants. Synthetic substances even when chemically identical with those of organic origin are supposed to cause abnormal development, a lower value as food and lower resistance to disease. I know of no evidence in support of this view.

The Search for Resistant Varieties

The long known difference in susceptibility to disease of different varieties of the same crop has been utilised in three ways for plant protection. Seed or tubers from healthy plants growing among a diseased crop are kept separate and grown again for a few generations to ensure that the plants really are resistant to the disease. Most of the older resistant varieties were obtained in this way. This method successfully dealt with Wart Disease of potatoes which appeared in Cheshire in 1902 and proceeded to work its way across England : nothing could be done against it ; even withholding the crop was ineffective, for the fungus could remain viable in the soil for 14 years or more. In 1908 however immune varieties of potatoes were found and from these many new ones have been raised by plant breeders. Trouble may crop up again, however : in 1942 two new races of the fungus were found in Germany capable of attacking some of the immune varieties[3] So far they have not been observed in this country, but they may still come. Alternatively a resistant variety found in some other country is imported : a classical example is the importation into France of American vine root stocks resistant to Phylloxera in the 1870's and 80's.

The third method, and by far the most certain, is by cross breeding : having found a variety possessing resistance this quality is transferred to non-resistant varieties posessing the other properties desired. This method was developed in Great Britain by Rowland Biffen, who at Cambridge had studied genetics under William Bateson, and Plant Pathology under Marshall Ward, and proceeded from 1900 onwards to fuse these two subjects. He worked with wheat, which is well suited to genetical experiments, and showed that some of its morphological characters, roughness of chaff, and colour in the seed coat, were simple Mendelian

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[1]Proc. 36th Indian Sci. Congress.

[2]Proc. Roy. Soc. B. 1951. Vol. 138, pp. 130-156.

[3]H. Braun, Z. Pfl. Krankh, 1942, Vol. 52, pp. 481-6.

characters ; and then proceeded to find whether resistance to Yellow Rust (*Puccinium glumarum*) was also. It was : and he produced rust resistant Little Joss by crossing a Russian Ghirka wheat, resistant to rust, with Square Heads Master, an old English variety with some admirable qualities but unfortunately susceptible to rust. This was the first instance in this country of scientifically building up a new variety by assembling in one plant desirable characters from two or more other sorts. Little Joss was a great success and the method has been much used since.

There was an element of luck in Biffen's work. Resistance to disease is not usually a single Mendelian character as it seemed to suggest. In general, resistance is complex, involving several genes, and depending on numerous morphological and physiological characteristics of the plant : the thickness of the cuticle, composition and osmotic pressure of the sap, and the general suitability of the cell for the growth of the invading fungus once it has got in. Resistance comes about in two ways : the organism may not be able to effect an entry, or, if it does get in, the plant may prevent it doing harm by sealing off the invaded cells, or in some other way. By reason of this complexity resistance is rarely, if ever, complete though it may be so good as to amount almost to immunity in the field.

The Black Stem Rust of wheat (*P. graminis*) presents more serious and difficult problems. Great Britain is practically free from this disease ; it occurs in south west Wales, in the corner where Cardiganshire and Pembrokeshire join—where its alternate host, the barberry grows ; but in the great Continental wheat regions of North America, Australia and Eastern Europe where most of the world's wheat is grown, it has caused terrible losses. In 1916 it was estimated to have destroyed 280 million bushels of wheat in Western Canada and the United States. Meanwhile investigations were proceeding at the Minnesota Experiment Station under the brilliant leadership of E. C. Stakman, later also in 1925 they were started at Winnipeg. Stakman showed that the fungus existed not only in different varieties, each adapted to a particular kind of cereal, but in many different physiological races having different degrees of virulence. He isolated the first of these races in 1917 ; by 1948 no fewer than 220 were known of stem rust, and 130 of leaf rust ; new ones are constantly being produced either by mutation or sexually, particularly on the alternate host, the barberry. This of course greatly complicates the work of the plant breeder. The first commercially successful wheat resistant to stem rust was Ceres, introduced by the Minnesota Station in 1926 ; it lasted ten years. A new strain of the fungus had appeared : Race 56 : which could attack it ; this gradually spread and by 1934 was the most prevalent race in the United States : in 1935 it made a virulent attack in one of the worst rust epidemics the States had known—and Ceres went down badly. The Minnesota staff then introduced Thatcher which was resistant to Race 56 : unfortunately it was very susceptible to orange leaf rust and to scab. It was therefore crossed with Hope, a variety resistant to leaf rust and after twice backcrossing to Thatcher gave a new variety, Newthatch, resistant to both stem and leaf rust.

Meanwhile the Canadian investigators at the Rust Laboratories at Winnipeg had been busy ; in 1939 they produced Regent, which became the most widely grown variety in the rust districts and later they improved on this with Renown and other sorts.

However a new and still more virulent strain of the fungus, Race 15 B, has been observed near barberry bushes in the Eastern States ; this can attack Newthatch and all other varieties of wheat now grown in the States. It is not yet widely distributed but that is only a matter of time. Other strains still more virulent than

15 B have since been found, some of them in Western Canada. Both the Canadian and the Minnesota plant breeders are producing new varieties of wheat in readiness for them when they spread[1].

Potato diseases are becoming increasingly important now the world food shortage is necessitating extended cultivation of this crop : in conditions as diverse as those of Scotland and India it produces twice as much food per acre as grain, often more. Unfortunately it is subject to a number of diseases and pests : fungus, insect and virus. The most terrible epidemic of plant disease on record was that which resulted in the appalling Irish famines of 1845 and later years[2], caused by the fungus, *Phytophthora infestans.*

Control afterwards became possible by spraying with a copper compound, but plant breeders have long been trying to avoid the disease by producing varieties of potato resistant to it. The methods are the same as for wheat : the world is searched for wild or cultivated varieties resistant to *Phytophthora*, and this property is then transferred to varieties lacking it though desirable in other ways. Some undesirable properties may also be transferred at the same time and these have to be got out by back crossing and selection. R. N. Salaman is the pioneer in this country. Among hybrids of a Mexican dwarf potato, *Solanum demissum*, he found some possessing a high degree of resistance. Crossing these with British susceptible varieties he obtained new resistant sorts possessing also good table and field properties. Then came a bad blight year (1933) and the resistant varieties went down. Salaman suspected that a new biotype of the fungus was concerned, and this proved to be correct : he called the old race " A " : to this his hybrids were resistant, to the new race " B ", however, they were not. A further search discovered the B-resistant gene and this was carried into a new variety. Continuing this synthetic process Salaman assembled in one plant resistance to blight and wart diseases, tolerance of virus diseases, and good field and table qualities : specimens were shown by him at the Chelsea Flower Show in 1939.[3] The work has been continued by W. Black at Cortstorphine.[4] In due course a third biotype " C " appeared to which the A B resisters succumbed. Again the early generations of *S. demissum* seedlings had to be searched : fortunately strains resistant to " C " were found ; and fortunately also the new hybrids resistant to A, B and C were also resistant to about 10 other strains of the fungus found in Germany. Meanwhile a still more virulent strain " D " has appeared in Tanganyika which can destroy several groups of the ABC resisters. It does not appear to have reached this country yet, but this may be only a matter of time. It is being investigated in Kenya by R. M. Nattrass, who has already found two other strains, E and F, also originating in Tanganyika but now widely spread over East Africa on tomatoes and potatoes.

Resistance to these various strains is not a simple property : four major dominant genes appear to be concerned in resistance to A, B and C. Nor is the transfer quite simple, for along with resistance some undesirable qualities are likely to be carried in, especially from a wild parent, and much backcrossing and selection may be necessary to get rid of them. When that is done desirable farming and commercial properties still have to be imparted.

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[1]The Minnesota work has been described by E. C. Stakman in *Science in Progress* (Yale Univ. Press), 5th Series, 1947, and the Canadian work by C. H. Gouldson, T. M. Stevenson *et al* in investigations on oats at Aberystwyth are described by E. T. Jones, *ibid* 199–204.

[2]For its history, see E. C. Large's very interesting book *Advance of the Fungi* (1940).

[3]R. N. Salaman (See also his book *The History and Social Influence* of *the Potato.*) Empire Jl. Expt. Agric. 1949, Vol. 17, pp. 238–244.

[4]W. Black *ibid.* pp. 114–124.

Remarkable results have been achieved : Black records that in four generations of breeding from the wild *S. Demissum* a variety has been produced combining field immunity, or a high degree of resistance, to blight strains A, B and C ; to wart disease ; several strains of virus A, X and Y ; leaf roll ; scab and storage diseases with good cropping capacity and cooking quality. It looks as if perfection is at last reached—but, he adds rather sadly, these qualities alone will not necessarily ensure success under general cultivation.

Breeding for resistance appears to be the only way of coping permanently with virus diseases of potatoes, though much could be done by fuller use of virus-free seed. Genes are known resistant to viruses A and X causing Mosaic disease and resistant varieties have been bred ; resistance to Y also causing Mosaic disease has proved more difficult to achieve. Some varieties are tolerant to a virus and can be infected without suffering injury, *e.g.*, King Edward and virus X— but of course they become carriers. Hop mosaic had been alleviated by E. S. Salmon, who produced hybrid hops tolerant of the disease and carrying it, but suffering no loss.

Fortunately, Dr. Kenneth Smith is here to discuss the possibilities of control of virus diseases, and equally fortunately F. Bawden is to open the discussion. The fundamental investigations they and their colleagues at Cambridge and Rothamsted are doing on the nature and properties of the different viruses and their relations to the plant must in the end furnish the best means of control.

In the meantime much can be done to evade the virus diseases by using only clean seed or stocks. Salaman has built up virus-free stocks of potato seed at Cambridge. The East Malling staff in their detailed studies of the viruses of soft fruit have isolated strains of strawberries and of raspberries, either free from known viruses or else containing only a single virus not known to be important ; in both cases growers were losing considerably, but these clean stocks have given new life to the industry.

But however successful it may be for a time, the search for resistant varieties is always dogged by the fear that some new strain of the pathogen may be produced before which the resistant varieties go down. It is like a race where a new competitor is always likely to turn up a lap ahead. Nevertheless it has given remarkably good results and is one of the surest ways of dealing with plant diseases.

Plant breeding against insect pests has also been done to some extent ; it may be more permanent unless the insects are able to mutate. The outstanding example in this country is the breeding of new apple stocks resistant to Woolly Aphid started at East Malling in 1920 by R. G. Hatton and M. B. Crane of the John Innes Horticultural Station then at Merton. Resistant Northern Shy stocks were crossed with the original East Malling stocks and from among many thousands of seedlings resistant strains over the whole vigour range have been selected for wider trial. The work has been extended by Tydeman, who is trying to produce resistant scion varieties of suitable quality.

R. D. Knight in the Sudan is putting longer and thicker hairs on to the leaves of the cotton plant in order to prevent the sucking Jassid insect from reaching the cells. He has already carried in two out of the three factors for resistance to Black Arm ; likewise he has added resistance to Leaf Curl which is controlled by minor genes ; he hopes further to add valuable cropping and spinning qualities—a really superb piece of plant synthesis.

Direct Action against Pests : Grain, Seed and Stored

The most effective way of dealing with a harmful organism is to kill it, and modern chemistry has provided many powerful agents for doing this. But undesirable secondary results may follow, especially with insects. An agricultural field or

an orchard normally contains a very mixed insect population, presumably in some sort of equilibrium with their surroundings and each other ; on the whole it may do little harm to the crop. When the equilibrium is disturbed one species may begin to multiply rapidly and finally reach the proportions of a pest. An outstanding example is the development of the Fruit Tree Red Spider Mite from an insignificant member of the orchard population to a serious pest, following upon the development of spraying programmes designed to control other orchard pests.

The simplest case of affording protection by direct killing of an injurious pest is in dealing with grain either before sowing or in storage. In neither case is any complication likely to result so long as the grain itself is not injured or, if it is being stored, does not absorb anything likely to be harmful to the consumer. Treatment of seed corn as a preventive against Smut is very ancient : seed borne fungi that remain outside the seed were first controlled by dusting the seed with copper carbonate ; this was replaced later, however, by the much more effective organic mercury compounds. Wheat, barley and oats in England and millet[1] in the Sudan are all protected in this way. Most British merchants treat the seed before selling it. W. A. R. Dillon Weston reports that, in the season 1921-2, 32 per cent. of the wheat samples examined at the Official Seed Testing Station, Cambridge, contained bunt balls ; since that time the percentage has steadily fallen and is now only about one. Leaf stripe of barley (*Helminthosporium*) is now so effectively controlled that College lecturers sometimes have difficulty in getting samples for their students.[2] The mercury compounds are of the type R-Hg-X where R is the radicle and X the acidic group. R and X can both be changed in a multitude of ways[3] : the toxicity can thus be adjusted so that the fungus can be killed but the seed spared. The solubility can also be varied allowing for both dry and wet treatments. One of these preparations is used in the Sudan to remove *B. Malvacearum* that causes Black Arm in cotton. Loose Smut of oats and barley, however, cannot be chemically controlled as the fungus is inside the seed.

The need for storing food grains free of all insect and fungus pests has become urgently important in view of the widespread unsettled conditions and serious shortages of today. There have been some serious losses : some months ago it was deemed expedient to store 25,000 tons of grain at Khartoum : 15,000 tons went bad. Even where preservation is perfect the grain may be effected. The Pest Infestation Laboratory which is doing good work on this subject has shown the DDT used to protect wheat grain appears in the flour and the bread, and in the tissues and excreta of hens and rats fed thereon, and as a metabolite in the urine of a man who had eaten an ounce of it.[4]

Protection of the Living Plant

(1) Biological control of insects and fungi

It is much more difficult to deal with the living plant in its relation to the population of mixed insects such as occur in the field, the orchard or the glasshouse. The gentlest method where it is practicable is to encourage the parasites or predators of the harmful insect. This biological control has all the attractiveness of any

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[1] this with copper carbonate.

[2] The rice species, however, is still common in India, and does much damage ; it was indeed an important factor in causing the Bengal famine.

[3] Much of the chemical work is unpublished and has been done by the manufacturers, particularly during the last war by I. G. Farbenindustrie. The pioneering testing in this country was by W. A. R. Dillon Weston and J. R. Booer. Journ, Agricult. Sci. 1935, Vol. 25, pp. 628–648.

[4] F. P. W. Winteringham *et al.* Sci. Food & Agric. 1950, Vol. 1, p. 214. The radio-active tracer technique was used in this investigation.

proposition offering something for nothing : unfortunately successes are comparatively rare. A striking instance is the control of Cottony Cushion Scale insect of citrus introduced into California from Australia without its natural enemies so that it was able to romp away and do considerable damage. But its predator, the Vedelia ladybird beetle, was brought in from Australia and reduced it to manageable proportions[1]. Another has been the almost complete extermination in Ceylon of the serious tea pest, Tea Tortrix (*Homona coffeearia*) by the parasite *Macrocentrus homonae* introduced from Java. This still maintains a high population level in spite of the disappearance of Tortrix, showing that it has been able to establish a balance with other members of the insect population.

The control of coconut moth in Fiji by an introduced parasite formed the subject of an interesting exhibit at the 1951 South Bank Exhibition.

We have a good example in our own country, though as far as I know, only one. A white fly was doing considerable damage in the Lea Valley glasshouse region : the Experiment Station introduced a Chalcid which parasitises its larvae : the fly is no longer a serious pest. In the Kenya coffee plantations a coffee mealy bug which has come in from Central Africa was doing much damage : Dr. Le Pelley was sent on a world tour to find some parasite : he found in Uganda a small wasp-like Hymenopterous insect that served admirably. From the Delhi Agricultural Research Institute a *Trichogramma* is distributed which parasitises the eggs of a stem borer and a root borer of sugar cane (*Argyris sticticraspis* and *Emmalocera depressella*) though I heard varying accounts of this in India.

The possibility of biological control of pathogenic soil fungi was recognised long ago when it was observed on culture plates that some forms are definitely antagonistic to others[2]. Two general methods have been studied. The saprophytic organisms may be stimulated *en masse* to multiply vigorously and so starve or asphyxiate the pathogenic forms. This was the principle underlying Millard and Taylor's control of potato scab in 1927 by heavy green manuring which greatly stimulated the antagonistic and competing organisms : the principle was used also by A. W. Henry and G. B. Sanford for dealing with cereal root rots in Canada and by S. D. Garrett in controlling Take-all in England.

The long known antagonism is now traced to antibiotics produced by some of the organisms, and fascinating prospects have recently been opened up of using these substances as control agents. Penicillin and Streptomycin are already widely used against human diseases : they have also been used against a bacterial crown gall killing trees in the gardens of wealthy Americans in Arizona[3]. This method is hardly likely to become general. But antibiotics produced in the soil may be used *in situ*. J. Rishbeth at Cambridge showed that *Trichoderma viride* which grows on the root surface of pine trees in acid soil produces the antibiotics gliotoxin and viridin which protect the root against the potent disease fungus *Fomes annosus*[4]. Very promising work on the subject is being done by P. W. Brian and his colleagues at the Butterwick Research Laboratories at Welwyn. They have isolated and studied various of the antibiotics produced in soil, and, perhaps most remarkable of all, they showed that one of them, griseofulvin, taken up from the soil by the plant, acted as a systemic fungicide protecting lettuce foliage from grey mould (*Botrytis cinerea*) and tomato foliage from early blight (*Alternaria solani*).

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[1] Quoted from R. A. E. Galley.

[2] See for example M. C. Potter, Journ. Argic. Sci. 1950-10, Vol. 3, pp. 102–7.

[3] J. C. Brown, Internat. Bot. Congress, Stockholm 1950.

[4] For other examples see the very interesting discussion by S. D. Garrett in Biological Reviews 1950, Vol. 25, pp. 220-254.
The subject was also discussed at Stockholm in July, 1950 at the Internat. Botanical Congress.

This can be complete but many difficulties may arise. The agent used to kill the insect or fungus may injure the plant doing more harm than the pest would have done. With fruit trees this danger is reduced to a minimum in winter, and potent washes are now available for killing eggs and resting forms without injury to the buds. The danger is much greater when the tree is in leaf but here the vegetable insecticides, pyrethrum, derris, nicotine, quassia, etc., are useful ; they are toxic to certain insects but harmless to the plant and also to domesticated animals. Pyrethrum is so much in demand that it is cultivated on a large scale in Kenya and is indeed, one of Kenya's chief exports, being sent largely to the United States. Since F. Tattersfield and his colleagues at Rothamsted isolated the toxic principles there is always the danger that they may be synthesised and that the natural product may be driven off the market as indigo was in the early days of this country, but a Research Group has been established to produce higher yielding varieties and to lower the costs of production.

Valuable though they are, these vegetable pesticides are limited in their application : chemical substances offer much wider scope. A few have been in use for many years, particularly Bordeaux mixture and sulphur : indeed Bordeaux goes back to the time before spraying machines were available and the operator had to walk along the rows of vines with a bucket of the mixture in one hand and a switch of heather in the other, flicking the mixture on to the plants as he went along[1]. The early substances were simple inorganic compounds of copper, arsenic or sulphur, but great advances have been made in recent years by the introduction of complex organic compounds, which can be prepared in long series with graduated properties capable of almost unlimited modification : and as a result of the modern combination of organic and technological chemistry they can be made on the large scale ; some among these are able to kill almost any insect or fungus.

In view of the many fundamental resemblances between plant and animal cells it is remarkable that they should differ so much in their reactions to poisons. The historic fungicidal elements are copper and sulphur, but neither are insecticides. Copper is particularly interesting because it is essential to fungal growth in minute quantities : indeed in Holland *Aspergillus niger* is used to test whether soils contain enough copper for plant growth. But the limit is rapidly overstepped and it was early discovered that two or three parts of copper sulphate in 10 million of water prevent the complete development of the spores of *Peronospora*. Improvements of these copper and sulphur sprays continues but the great progress has been with the mercury organic compounds. Reference has already been made to their use as seed dressings : phenyl mercury chloride and phenyl mercury acetate are also used as early sprays for the control of apple scab. But there are wider possibilities : cerium, cadmium and uranium salts are also toxic to fungi ; those of esmium and silver apparently even more so than those of mercury[2].

But with all the advances made there is as yet no good soil fungicide for use in the field. Formaldehyde has long been used in glasshouses against foot rot, Verticillium Wilt and other fungus diseases, and still remains the most efficient soil fungicide. Following the analogy of the high efficiency in their respective fields of organic phosphorous and organic mercury compounds, it might be anticipated that organic sulphur compounds would prove useful, but that remains to be seen.

These fungus problems are being treated by Mr. Cronshey and we may expect a useful discussion on them.

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[1]E. C. Large. Advance of the Fungi ; p. 229.

[2]S. E. A. McCallan and F. Wilcoxon, Contrib. Boyce Thompson Inst. 1934. Vol. 6, pp. 479–500.

Chemical Control of Insects

The most spectacular advances however have been with the insecticides, and here the chemists have built up synthetic substances of great complexity the manufacture of which is a marvel of chemical technology. One of the first to capture the imagination of the world was the Swiss product D.D.T. which has proved extraordinarily effective for a wide range of purposes : in the home against the housefly, in tropical jungles against the tsetse fly, in grain stores against weevils—although houseflies and other insects can become resistant to it. Like the other organic insecticides it is selective, potent against some but sparing others, and it soon appeared that spraying with D.D.T. while effectively destroying one lot of insects, allowed another lot to flourish and become a pest. Its use was followed by infestation of Fruit Tree Red Spider Mite and Woolly aphis in this country, by increases in the Egyptian Boll Weevill in the Sudan, and in the numbers of Red Banded Leaf Roller in Canada where it was used against the Codlin Moth. This is, of course, part of the price to be paid for selectivity : it is an extremely valuable property but its possession means that the entomologist must know exactly which members of an insect population will be killed and which spared : he must then be able to forecast the probable effects of the insecticide in setting up a new population.

The British gamma benzene hexachloride (called B.H.C. for short) is no less potent and may prove more generally useful.

Still more potent insecticides are becoming available. Phosphorus is proving as useful a centrepiece for the entomologist as mercury for the mycologist ; some of its complex organic compounds, *e.g.*, parathion, are remarkably toxic to aphids and mites—insects resistant to many other insecticides. Unlike D.D.T. and benzene hexachloride they may be harmful to men and domestic animals : proper precautions must be taken in using them. Mr. Stapley is giving us an interesting comparison of these three substances.

Meanwhile, the means of distributing the insecticides and fungicides have been improved out of all recognition especially for large scale work. Low volume mist sprayers have greatly reduced the quantity of material needed and have increased its potency. Operations are now practicable that would have been impossible a generation ago. In the Sudan last year nearly 78,000 acres of cotton in the Gezira were sprayed against Jassid, and another 15,000 acres in the White Nile : it was done from a helicopter : in no other way could so large an area have been treated in time. Another important development has been a great extension of spraying by expert contractors.

An Old Problem Solved. Soil Insecticides

These new materials have solved a problem which had long baffled investigators: they have provided an effective soil insecticide for field use. The French vine growers long ago used carbon disulphide against root lice on their vines, and English tomato growers in the Lea Valley glasshouses used Cresylic acid against root eelworm : rather large quantities were needed because it decomposed fairly quickly in the soil. We at Rothamsted suggested putting in chlorine atoms to make it more stable and to intensify the action but this was not at the time practicable. None of these substances could be used on the farm, and wireworm, perhaps the worst of our soil insects, was unconquered. Well do I remember our anxiety during the first world war because of the great loss it caused in wheat grown on the ploughed up old grassland : even during the second war losses were reduced only by suiting the cropping to the density of the wireworm population as estimated by methods worked out during the interwar period. Field observations indicated losses averaging 0.6 cwt. per acre of wheat and oats for each 100,000 wireworms per acre, and as the numbers might not infrequently be of the order of one million, the aggregate losses

were considerable[1]. But now B.H.C. has proved an effective control agent for farm use. It can be mixed with an organic mercury compound and applied to the seed so as to protect against both wireworm and seed-borne fungi.

Eelworms which do so much damage to potatoes, sugar beet and other crops, have proved particularly difficult to deal with and we shall all listen with great interest to what Dr. Holmes will have to say on the subject.

A New Approach : Systemic Insecticides

In the early 1920's, J. Davidson at Rothamsted showed that pyridine fed to broad beans made them distasteful to aphids. No practical field method could be worked out, however, for protecting the crop and the matter dropped. Entirely new possibilities of control were opened up by a group of organic phosphorus compounds which are absorbed by the plant and render it poisonous to insects feeding on its sap. They are thus perfectly selective, killing the insect that is about to damage the plant but leaving its natural enemies untouched.

These systemic insecticides seem to offer a way of dealing with the virus diseases transmitted by aphids. The ordinary insecticides come too late : the disease may already have been transmitted before the act, the systemic insecticides may prevent the infection. An attempt is being made in West Africa to use them against the dreaded Swollen Shoot disease of Cocoa which has caused serious economic and political troubles. They cannot cure trees already affected but they can protect unaffected trees. They have the further advantage that they enter the plant and are not washed off like the ordinary insecticide ; their presence may be objectionable or even harmful if the plant is to be used as human or animal food. This applies to all of the modern insecticides and emphasises that they should be used with great care and not applied near the time of harvest. S. H. Crowdy and R. L. Wain have demonstrated systemic fungicidal activity in compounds of similar structure to active plant growth regulators.

Herbicides and Growth Promoters

These complex organic insecticides and fungicides represent points in a chain of compounds of similar chemical pattern where toxicity to the harmful organism is sufficiently marked to put it out of action, but the toxicity to the plant is sufficiently low to cause no injury. A change in the pattern may modify these effects and bring into prominence the toxic action on plants, any insecticidal properties being less important. These substances are the herbicides and some among them that are selective in their toxicity are being used as weed killers. Some are directly poisonous, others are of the hormone type and act presumably by disturbing the physiology of the plant. These were discovered in 1941, and will be described to us by Dr. Sexton and Dr. Templeman. Some of them, notably 'Methoxone' and 2, 4 D, have come into wide use both in cereal cultivation and for grass land. No less than 13½ million acres are reported to have been treated in the prairie provinces of Canada in 1950 against only about half that acreage in 1949. By obviating the need for special cultivations they reduce not only the cost of production but, in semi-arid condition, the risk of soil erosion also. In any conditions weeds cause considerable loss in early stages of crop growth ; later on the effect is less harmful and may even be beneficial in arid regions liable to erosion. But these herbicides must be used with great care as many crops are extraordinarily sensitive to them; as little as 0.002 mgm. of 2, 4 D borne by the wind affected cotton plants[2].

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[1] *See* Wireworms and Food Production, Bull. 128. Min. Agric. and Fisheries.

[2] Staten, Dunlap and others quoted in " Advances in Agronomy " Vol. II. 1950 (Academic Press N.Y.)

The Increase of Plant Diseases and Pests

The present century has seen an unprecedented increase in our knowledge of insect and fungus pests and in the means available for combating them. But there has also been an enormous increase in the number of the pests and in their recorded prevalence. To some extent this is due to closer observation and better diagnosis : some of the diseases may be of long standing but only recently studied, such as Eye Spot and Take All of wheat. Many of them have come in from other countries, and modern transport is so rapid and multifarious that permanent exclusion of any pest capable of living in our conditions and feeding on any of our crops is extremely difficult if not impossible. America has, during this century, supplied us with American Gooseberry Mildew and Wart disease of potatoes ; the Colorado beetle has not yet secured a footing though only because of much watchfulness and now preventive spraying. We may still get the very serious *Thecaphora Solani* at present confined to the highlands of Peru, Venezuela and Columbia but capable of doing great harm to our potatoes if it arrives here. Nor have we ourselves been guiltless ; in the early days America got from us the Gypsy moth, Brown-tail moth, European corn borer, pea thrips and a variety of others which are now pests. In the case of the fungi the newcomer may be an old form that has suddenly produced a more virulent mutant, like the Verticillum Wilt that for years had lived harmlessly in Kentish hop gardens and then suddenly in 1924 in a hop garden at Penshurst, assumed a destructive habit, spread and became a bad pest. Fortunately two of Salmon's new varieties have been proved by Keyworth to be resistant. The Downy Mildew of hops formerly known only in Japan suddenly appeared in the Wye hop garden in 1920 and within ten years had spread into all the hop growing districts. Instances could be multiplied. Kenya has already acquired a serious canker of Macrocarpa that threatens to put this useful tree out of cultivation. It is caused by a fungus *Monochaetia uniformis* previously known only as a herbarium specimen in Kew, Pretoria and California. Kenya's valuable pyrethrum crop suffers severely from a bud disease caused by *Ramularia bellumensis* known only as a comparatively harmless fungus in glass houses in Cheshunt and in Italy.

Insects do not appear so readily to change their habits and become pests : the classical example is, of course, the Colorado beetle which lived blamelessly in Western America till the 1860's when the first settlers introduced the potato. In our own country a Capsid that used to feed on willows suddenly took to apples and became a major pest.

The Blister Blight of tea (*Exobasidium vexans*) has now appeared in Ceylon : if it cannot be checked it may seriously reduce the crop and the vigour of the bushes. And so one could go on. Sometimes a new crop has been introduced bringing a new pest like the sugar beet eel worm or a new plant that forms an alternate host : like the barberry which was introduced into North America. An introduced crop may suffer from an insect harboured by a native crop which therefore may have to be sacrificed ; in the Sudan the popular vegetable Lady's Fingers harbours a minute white fly that damages the long staple cotton in the Gezira and so the vegetable is prescribed in that region. Happily, the mite does not effect the American cotton grown in the non-irrigated regions : people can, therefore, eat Lady's Fingers there. A new insect coming in may displace another that has been keeping down a pest and so in a kind of third party relationship it may enable the pest to damage the crop. In Zanzibar an indigenous ant, *Cecophylia longinoda* preys upon a Coreid insect which is liable to damage the young female flowers of the coconut and so of course reduce the yield, and in the area where it is active damage is only slight. But an exotic ant, *Anaplolepis longipes* has in certain districts driven out Cecophylia; it does not prey upon the Coreid, which can therefore multiply and the yield of coconut falls. Control of Anaplolepis could no doubt be effected.

A complicated problem would arise, however, if as seems possible, Sudden-Death of cloves in Zanzibar should be a virus disease transmitted by the Scab insect *Saisetia*. For this insect is attended by the ant *Cecophylia longinoda* and by it carried

from tree to tree and protected from parasites and predators. In that case should Cecophylla be spared in order to save the coconuts or destroyed in the hope of saving the cloves ?

Changes in agricultural practice such as have taken place in this country in recent years may alter the balance of insect populations and bring one or other into prominence or cause it to change its habits, for example, the crowding of potatoes caused the eelworm to multiply. Even a great agricultural triumph like the 500 mile northward extension of the Corn belt in the upper Mississippi Valley through the introduction of an earlier ripening maize, may raise new difficulties : the stalks and stubbles proved admirable for the over-wintering of scab or head blight of wheat and barley and great losses of those crops have followed.[1] The modern tendency to larger scale cultivation of particular crops favours accumulation of their pests. Wigglesworth has pointed out that our small fields, considerable range of crops, our hedgerows and road side verges encourage a variety of insect predators and parasites: as we smooth out the variety in accordance with modern tendencies to uniformity so we increase the risk of insect pests. North America, whose large scale methods we are sometimes urged to follow, suffers more from insect pests than we do. The very care taken to control them has, in some cases at least, been accompanied by increases because their natural enemies and predators had been destroyed. A. D. Pickett[2] states that six or even ten sprayings are now required in the orchards of Nova Scotia to get good quality fruits, whereas only two or three were needed 50 years ago. Dr. V. B. Wigglesworth discussed this whole question in an address at the British Association in 1950 and emphasised the need for fuller study of the effects of insecticides on the whole insect population, and for developing biological methods of maintaining a proper balance in the insect population. Chemical methods alone in his view will not suffice : " the problem of pests in general," he says, " gets worse .....new machinery and new chemicals are developed and we are carried from crisis to crisis always hoping that the newest chemical or the newest technique will provide the final answer." Other entomologists, *e.g.*, R. A. E. Galley, C.B. Williams and others take a similar view and put the emphasis on the population rather than on the individual species. Undoubtedly, the problems would become much simpler if it were possible to maintain the insect population in a condition where mutual interactions prevented any one species from increasing to the dimensions of a pest. Fortunately, a strong East Malling team in association with Dr. Wigglesworth's Unit of Insect Physiology is now studying the general problem from a wide point of view. The purpose is not so much to search for remedies for particular pests and diseases—important though these are—as to study the interrelation of the organism concerned with the host plant. This indeed has long been East Malling's attitude, developing from the experimental approach of Hatton and his co-workers in the early days. Examples may be found in the work of Massee, Blair, Collyer, Austin and others on the Fruit Tree Red Spider Mite, in Wormald's and Cross's work on bacterial Canker, in Moore's on Brown Rot of Apples and Plums, and in Dicker's on Fruit Aphids. The present studies deal with the insect population of the orchard as a whole, especially the beneficial insects. Instead of confining the work to the pest and the insectcide, plant protection is recognised as requiring the widest ecological studies to determine the probable ultimate effects of the treatments adopted.

I need not enlarge on this view ; Dr. Holmes is discussing it. I agree entirely that one of our greatest needs now is for more fundamental knowledge.

The Increasing Struggle for Higher Output

The problem is really widespread. The conditions of our time require high levels of output of food from the land, and in attaining these we are perpetually disturbing Nature's balances and coming into unexpected difficulties. The plant

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[1] C. E. Stakman, *loc. cit.*
[2] Canadian Entomologist 1949, Vol. 81. pp. 1.

breeder's latest successes may succumb to a new strain of the fungus he thought he had defeated. The agronomist may find his new intensive methods lead to soil deterioration or even erosion. An irrigation scheme may be a triumph of modern engineering, but it may speedily be followed by water logging, salting and other soil troubles. It is as true today as when Horace wrote : " You may expel Nature with a pitch fork but she always comes back again." Our problems, like Einstein's Universe are perpetually expanding. Does this mean that we must give up the struggle ? Not in the least. We must go on seeking first to learn all we can about the plant in health and disease, studying in the fullest extent the relations of these various organisms one to another ; remembering always that any interference with one group of organisms may upset some delicate balance and lead to quite unexpected results. The plant protector started as a priest armed with incantations, a sheep and a reddish sucking puppy for sacrifice : he has developed into a modern scientist equipped with well founded knowledge and efficient appliances both of which are constantly widening and improving. Close, careful observation, clear thinking and a broad minded approach to his problems still remain his greatest assets in his work.

A DISSERTATION UPON DRINK

By

James Lamb

The part played by tea in English life and customs is worthy of the interest of those concerned in the production of this beverage, and so a dissertation on the subject is not out of place in the *Tea Quarterly*.

For over three hundred years the consumption of tea in England has been increasing and indeed one of the characteristic meals of the Englishman has become known as "Tea", or among the best people as " Afternoon tea ".

It is supposed that tea was introduced into Europe about 1610 and into England (from Holland) about 1650. Pepys in his diary entry for 25th October 1660 records, " and afterwards I did send for a cup of tea (a China drink) of which I had never drunk before."

Lemmy Caution (the American detective character of the late Peter Cheyney) who, incidentally, has several interests in common with Mr. Pepys, aptly summarises in his usual racy style the American impression of the part which tea plays in present day British life.

" Here is another thing that makes the English a great race. Every time some British guy gets himself run over, or shoots somebody or goes into war, or blows somebody up or does some other goddam thing, he always has a cup of tea—before an' afterwards. I know it aint in the history books but I am prepared to bet a blue silk garter that some dame once give me for showing her the way home in the earthquake, to a couple million dollars, that when Juilus Caesar landed in Britain he found the local mob sitting round the sea-shore fillin' the football coupons and rinking tea outa sea-shells ". ("You'd be surprised," by Peter Cheyney.)

In this age of tension a cup of tea has become the standard antidote to mental strain. In 1945 the *Tea & Coffee Trade Journal* under the caption " Tea: A War Potential " printed the following remarks[1] :—

> " Beverage tea has been a war potential. It has sustained and comforted the armed forces ashore and afloat, the defence workers during the blitz, the bombed-outs, the doodle-bugged and the evacuees. And it has been in evidence right round the clock in the homes of the people, especially during the night watches when sleep is out of the question and it is mostly a matter of being on the alert. In all moments of mental strain and physical anguish it has been the teapot that has brought comfort and a link with sanity and tradition. When the history of this war comes to be written it can be said of tea that it played a far more important part in the lives of the people than it did even in peacetime, which is saying lot.
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> Americans in their hundred thousands have, while in Britain, become acquainted with the war-time panacea of hot tea. Americans have become tea-minded. It is said that at a large office in the metropolis where British and Americans work together in pursuit of the common goal—victory—when a list was recently sent round for those wanting hot tea each day 60 names were supplied, 40 of them being American ".

What property affords tea the power of stimulation, and has it earned the name, the " cup that cheers " ? Undoubtedly, it is the caffeine content which produces the feeling of well being, which stimulates mental activity, and which reduces fatigue.

Clark in his Text book of Applied Pharmacology remarks[2] " Man has displayed remarkable ingenuity in finding drugs which produce actions on the central nervous system. Savage tribes have discovered independently the most varied methods for producing alcohol, and most races have discovered some source from which they can produce drinks containing caffeine or its allies ".

Tea, Coffee, Cocoa, Yerba matè, Kola nut and the various aerated drinks made from Kola—some with added caffeine, are all examples of stimulants containing caffeine and its allies. The natives of West Africa chew Kola nut for precisely the same reason as people in London, Paris and New York drink their tea, coffee or " coke ".

There are, of course, critics of this addiction to caffeine. There were critics two hundred years ago. One of the most vehement attacks on tea came from Jonas Hanway in 1757[3]. He pointed out that four million pounds of tea had been imported into England. " When will the evil stop?" he asked. In his, not so humble, opinion " your very chambermaids have lost their bloom, I suppose, by sipping tea ". After an equally violent attack on gin, he added, " What an army has gin and tea destroyed ".

In the library of the Tea Research Institute we have a copy of a book printed in 1772 entitled " The Natural History of the Tea Tree with Observations on the Medical Qualities of Tea and Effects of Tea-drinking " by John Coakley Lettsom, M.D., F.S.A. Dr. Lettsom was of the same school of thought as Jonas Hanway and predicted dire consequences from the increasing consumption of tea.

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[1] Planters' Chronicle, Vol. XI, No. 3, 1945, page 41.

[2] Applied Pharmacology, A. J. Clark (J. & A. Churchill Ltd., 1942).

[3] Essay on Tea by Mr. Hanway, 1757

Tea brokers seem to be particularly liable to what he describes as " Universal fpafms ". His treatment of one case may interest any present day brokers subject to " universal spasms ".

> " An affiftant to a Tea broker, had frequently for fome weeks complained of pain and giddinefs of his head, after examining and mixing different kinds of tea, the giddinefs was fometimes fo confederable, as to render it neceffary for a perfon to attend him, in order to prevent any injury he might fuffer from falling or other accident. He was bled in the arm freely, but without permanent relief, his complaint returned as soon as he was expofed to his ufual employment. At length he was advifed to be electrified and the fhoks were directed to his head. The next day his pain was diminifhed,but the day after clofed the tragical fcene. I saw him a few hours before he died, he was infenfible, the ufe of his limbs almoft loft, and he funk very fuddenly in to a fatal apoplexy. Whether the effluvia of the tea, or electricity was the caufe of this event is doubtful. In either view the cafe was worthy of attention ".

The cheerful admission that it is doubtful " Whether the effluvia of the tea or electricity was the cause of this event " is an interesting sidelight on the standards of medical treatment of the day.

Dr. Lettsom was prepared to admit that tea could be useful on certain occasions. " It is an obfervation I have often had occafion to make, that people after violent exercife, or coming off a journey much fatigued, and affected with a fenfe of general uneafinefs, attended with thirft and great heat, by drinking a few cups of warm tea, have generally experienced immediately refrefhment. It alfo proves a grateful diluent, and agreeable fedative, after a full meal, when the ftomach is oppreffed, the head pained, and the pulfe beats high."

The meals consumed in Dr. Lettsom's day were fantastic by modern standards and are in themselves a fascinating subject. Professor Drummond's " The Englishman's Food " and Parson Woodforde's Diary (which has recently been published in an abridged form) are most illuminating sources of information to anyone interested in the subject. Local customs do indeed change for it is now almost incredible that a physician should accept gorging to the point of headaches and high pulse as a normal " full meal " and recommend tea as a " grateful diluent ".

Even in Dr. Lettsom's and John Hanway's time there were medical men who believed in the virtues of tea. Dr.Lettsom says, " We seldom perceive the rudiments of scrofulous diseases so often as in the weak feeble offspring of the inhabitants of towns, and whose breakfast and supper often consist of weak runnings of ordinary tea ". Another authority[1] of the same age, however, observes " and with drinking of tea only and regular living, the distemper of England occasioned by our too much feeding upon flesh may be cured."

The distemper referred to was probably scurvy which would only be affected by green tea, because Vitamin C, the lack of which causes scurvy, is destroyed during fermentation in the manufacture of black tea.

It is difficult to discover whether black tea as we know it today was imported into England in the early days of the tea trade. From Lettsom's description of dry leaf and liquor, the teas he examined were all either green teas or lightly fermented Oolongs. He remarks of green tea :—

> " As green tea is by some suspected to have been cured on copper, they have attributed the verdure to the efflorescence from that metal, but if there were any foundations for this supposition, the volatile alkali (Ammonia) mixed

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[1] A Treatise on the Inherent Qualities of the Tea Leaf, J. N. Pechlinas from the Latin, by a gentlemen of Cambridge, 2 Edition, 1750.

with an infusion of some tea would detect the least fraction by turning the infusion blue. Others have with less propriety, attributed the verdure to green copperas, but this ingredient which is only salt of iron, would immediately turn the leaves black and the infusion made from the tea would be of a deep purple colour. Is it not more probable, that some green dye, prepared from vegetable substances is used for the colouring ? "

These remarks reflect the common and quite indiscriminate use of the salts of heavy metals in those days before the introduction of Food and Drugs Laws.

Green vitriol or copperas was commonly added to beer to give it a head. Even lead salts were used to correct acidity in wines, beer and cider, whilst the storage of cider in lead vessels was a common practice.

Afflictions such as " universal spasms," scrofula and even scurvy may well, in many cases, have been due to poisoning with lead or other heavy metals.

In any case, however, the consumption of large quantities of green tea, especially with a very ill-balanced diet, may have given the detractors of tea some grounds for their assertions.

In spite of three hundred years of tea drinking there are still people who just " do not hold with tea ". It is not uncommon to hear a soap box orator in Hyde Park denouncing tea, coffee, strong drink and the Government. The Londoner having given him or her a hearing, will usually end the feast of rhetoric by wandering off for a cup of tea or a drink.

Tea is now accepted as a harmless beverage and Professor Clark in his text book which I have already quoted merely comments :—

" *Tea and Coffee :* The enjoyment of these substances is not attended by any ill effects on the vast majority of the population ". He goes on to add, " The drinking of very strong green tea has become a habit in North Africa (Tunis and Egypt) which is stated to be producing deleterious effects. In this case the volatile oils are suspected of producing toxic action on the central nervous system ".

All foods and drinks in excess are, of course, harmful and even now-a-days, especially where highly concentrated foods such as sugar and starchy confections form a large part of the diet, many people still ' dig their grave with their teeth '.

Dr. Roche Lynch a former Home Office Pathologist is doubtful, however, of the allegation that even excessive tea drinking could produce harmful effects. In a paper on ' The Pharmacology of Caffeine and of Tea and Coffee ', he reached the conclusion that " From post mortem examinations I do not believe that any changes occur in those who have drunk largely of the beverages of tea and coffee, which can be associated with such drinking ".

During the course of three hundred years black tea has, therefore, risen to the position of a staple of the Englishman's diet. The cup of tea is no longer regarded as a rival to beer, spirits or wine, and each has a separate place in our social customs. Few people indulge in a cup of beer at four o'clock or a tankard of tea with a game of darts. This has not always been the case, and there is no doubt that tea has brought about many social changes almost wholly to the improvement of health and social standards.

We are now so accustomed to having supplies of clean water that we take drinking water for granted. Sanitation is a comparatively very, very modern science and most of the water available for drinking, at least in the larger towns,

must have been unattractive even to the less squeamish stomachs of Pepys' day. I recall, though I cannot at the moment find the entry, that Pepys actually records that he took a glass of water and expressed himself in such a way as to leave the impression that he normally drank wine or ale. Apart from festive occasions, Pepys, consumption of fluid was probably much lower than would be normal today and may have contributed to his trouble with " the stone ".

Pepys was not wholly insensible to sanitary conditions. Underneath his house were cellars where coal and wine were stored and which also housed the sanitary conveniences, such as they were. He records one night that he stepped " into a great heap of.. ..by which I find that Mrs. Turner's house of office is full and comes into my cellar which do trouble me ". A month later a great deal of ' foul water ' came into his parlour under the partition on the other side of the house adjoining Mr. Davies'.

Plain water from a town well could not under such conditions of life have been palatable to anyone of any sensitivity.

Even in the nineteenth century a sewer ran through the court yard of Buckingham Palace and the paint in a freshly painted basement room was turned black overnight by the action of gases from the sewer. Parliament was at times greatly inconvenienced by sewage in the river.

Victorian England was subject to terrible outbreaks of cholera which arose from contaminated drinking water. In 1851 " Punch " writing of the Great Exhibition said " The contractor is bound to supply gratis, pure water in glasses to all visitors demanding it, but the committee must have forgotten what whoever can produce in London a glass of water fit to drink, will contribute the rarest and most universally useful article in the whole Exhibition ".

Although the actual connection between impure water and disease was not understood until comparatively modern times, it was long realised that contaminated water was harmful, and the degree of contamination common in large towns would have rendered it extremely distasteful. A beverage such as tea which could be taken with boiled water would, therefore, serve an extremely useful purpose, supplementing or providing an alternative to wine and ale which poorer people could not, even in those days, afford in any quantity, thus making available a safe drink, and probably generally increasing the total intake of fluid. I should imagine that plain water would only be drunk to satisfy extreme thirst and that poorer people did not drink sufficient water to keep them healthy.

Drummond and Wilbraham[1] quote evidence that even in the sixteenth century water was suspect as a drink.

The amusing lines on drinking show firstly, the popularity of wine and secondly, a deep distrust of water, a distrust shared by many contemporary writers. This is not surprising, for the character of the water supplies was, with few exceptions, appalling. Water-borne infection must have been so common that it had been established empirically that it was safer to drink wine or beer. Water was, however, thought to be fairly innocuous when drunk with wine, as of course it might be.

> .....wyne and other drynkes be the most profitable medycynes and pleasant repasts, nothyng hurtful moderately taken, sometyme it is better drynke clere wyne than to delay it with water, if water be so myngled but drunke alone it causeth other drynkes to be more dangerous. It is therefore conuenyent that euery day we use to put one or two glasses of water in to our

[1] The Englishman's Food, J. C. Drummond & A. Wilbrahm (Jonathan Cape), 1940.

wyne, both to delay the fume of the wyne and make our bodyes lyghter, and also in case nede shuld constrayne us, by this use without daunger we may learne to drynke water.[1]

Wyne was held to be better than ale or cider, for these lacked 'heate and moysture', that is, they were less nourishing, for good digestion proceeded by the operation of these qualities.

The introduction into England of an economical beverage, warming and stimulating which, being made with boiling water was a safeguard against all too common water-borne diseases was destined to have an increasingly marked effect upon social customs from the seventeenth century onwards.

Drummond and Wilbraham in their treatise upon "The Englishman's Food" from which I have already freely quoted have much to say on this subject. I strongly recommend this book for general reading and much of the information I quote in the rest of this article is gathered from this source.

Thus between pages 234 and 244, Drummond and Wilbraham state :—

"No change in the habits of the English is more striking than the adoption of tea-drinking by all classes. Tea had been steadily becoming cheaper towards the end of the seventeenth century as imports from the East increased, and the trade expanded enormously after 1700. In that year about 20,000 lbs. was imported, within ten years this figure was trebled. In 1715 the market was flooded with Chinese green tea and in 1760 duty was paid on over five million pounds. By the end of the century the amount imported was over twenty million pounds, that is, about 2 lbs. per head of the population.

In addition to these official figures we have to allow for the amount which was brought into the country as a result of brisk smuggling trade with France. It was estimated that in 1766 as much reached England illegally as came through the proper channels.

This change in habit surprised everybody and disturbed not a few. Some people feared that tea would supplant ale and beer. In 1744 Duncan Forbes wrote:—

'But when the opening of trade with the East Indies..... brought the price of Tea.....so low, that the meanest labouring men could compass the purchase of it, when the connection which the dealers in this country had with many Scotsmen in the Service of the Swedish Company at Gottenburg, introduced the common use of that drug amongst the lowest of the people,—when sugar, the inseparable companion of tea, came to be in the possession of the very *poorest* housewife, where formerly, it had been a great rarity—and thereby was at hand, to mix with water and Brandy, or Rum—and when tea and Punch became thus the Diet and Debauch of all the beer and ale drinkers, the effects were very suddenly and severely felt'[2]

'Any person who will give himself the trouble of stepping into the cottages of Middlesex and Surrey at meal-time, will find, that, in poor families, tea is not only the usual beverage in the morning and evening, but is generally drunk in large quantities at dinner. Whether this exotic is more palatable or more nutritious than home-raised barley converted into broth, I leave to Medical gentlemen to determine.'[3]

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[1]The guoernance of good helthe, by the most excellent phylosopher Plutarche, the most eloquent Erasmus beynge interpretoure, 1530.

[2]Some Considerations on the Present State of Scotland, Duncan Forbes, 1744.

[3]The State of the Poor, Sir Frederic Eden, 1797.

The amount spent on tea by working class families was considerable. The family budgets given by Eden show that it was not uncommon for two pounds a year to be so spent when the total income was only a matter of forty pounds a year, and Arthur Young expresses surprise that the inmates of the Naction House of Industry, who were allowed to spend 2*d.* out of every shilling they earned on food, almost invariably bought tea and sugar with this money[1].

Enterprising individuals seized the opportunity of making money out of a gullible public by selling them the essential medicinal essence of tea and Mr. Lawrence at his Toy Shop, at the Sign of the Griffin in Poultry, offered a ' Chemical Quintessense of Bohee-tea, and Cocoa nuts, wherein the Volatile salt, oil and spirit of them both, are chemically extracted and united.'[2] The consumption of sugar rose as the habit of tea-drinking spread. It had ceased to be a luxury as the trade with the West Indies developed and ordinary white sugar candy cost about 6½*d.* a pound in the first half of the century, refined varieties being about 2*d.* a pound dearer. The price rose a little after 1750. Later in the century attention was drawn to the possibility of preparing sugar from roots such as carrots and beets. The first reports came from the Continent, where successful extractions had been made by Marggraf and by Achard. These were only small-scale experiments, but in 1798 it was announced that Professor Klaproth had succeeded with a large-scale extraction. The discovery aroused little interest in England outside the pages of the scientific journals.[3]

The popularity of tea brought about a sharp decline in the sale of coffee, cocoa, and chocolate, all of which were a great deal more expensive than tea, and towards the end of the century many of the once famous coffee houses had disappeared.

On pages 246-247 and also on page 249 of " The Englishman's Food ", Drummond and Wilbraham quote much information from Sir Frederic Eden's " The State of the Poor ", published in 1797 which is not available in Ceylon, and I have only once had the opportunity for browsing through the work in a library in England.

The family budgets shew the place which tea was taking in the diet of families in the eigthteenth century.

" The contrast between the north and the south of England late in the century can best be illustrated by taking two of the typical family budgets which Eden compiled. The first represents the amount spent on food during one year by a labourer, with a wife and four children. living at Streatley in Berkshire. The total family income—the wife and two of the children also worked on the farm—was £ 46 a year. The second budget is that of a labourer, his wife, and three children, living at Kendal in Westmorland and having a yearly income of under £ 30.

The Streatley family estimated their weekly consumption of food as follows :—

8 half peck loaves
2 lb. cheese
2 lb. butter
2 lb. sugar
2 oz. tea
½ oz. oatmeal
½ lb. bacon (usually boiled)
2*d.* worth milk (probably about 2 pints)

[1] The Farmer's Tour through the East of England by Authur Young, 1771.

[2] Advertisement in the Tatler, No. 97, 1709.

[3] Journal of Natural Philosophy and the Arts, edited by William Nicholson, 1797-1802

It is stated that they rarely ate meat and could seldom afford potatoes. The cost of their food amounted to over £ 52 a year, a sum already greater than their income and revealing the effect of the high prices in the south towards the end of the century.

The family in Westmorland spent the following sum in one year.

	£.		
75 stone of oatmeal, @ 2/4*d.* the stone	8	15	0
Butcher's meat (probably 5*d.* a lb.)		5	0
Milk (probably 1½*d.* a quart)	5	0	0
Tea and Sugar	1	12	0
Potatoes (probably 3*d.* for 4 quarters)	2	12	0
Butter, 50 lb. @ 9*d.* a lb.	1	10	0
Treacle		8	0
£	20	2	0[1]

From the wealth of information in Eden's great survey we can take another interesting budget. This represents the expenditure of a labourer living at Epsom, with his wife and eight children, on a yearly income of £. 45–50, which was by no means bad for the times. He was fortunate in having a small garden and being able to fatten a pig every year. His weekly purchases were estimated as follows :—

13 quartern loaves
1 joint of meat (*i.e.*, about 12 lbs. (4/-) for Sunday)
1½ lb. butter
1¼ lb. cheese
Tea and 2 lb. Sugar
Small beer, 1½*d.* a day[2]

The mention of beer is worthy of note as it is seldom met with in the estimates quoted by Eden. Tea and sugar, on the other hand, are almost universal. We shall refer to this again later, but in the meantime, we may note what Eden says :—

> " They (farm labourers) seldom, however, can afford to purchase beer, and in its place, have very generally in this part of the country substituted tea at every meal."

Parson Woodforde[3] makes many references to tea in his diary between 1758 and 1802. On may 27th, 1763, he states the price of tea both green and ' Bohea '. What he describes as ' Bohea ' would, I believe, be called ' China tea ' today.

> ' May 27th, 1763. For an ounce of green tea paid 0.0.8. For an ounce of Bohea tea paid 0.0.4*d.*'

Whilst waiting for the Coach to Norwich, Parson Woodforde, in the company of his niece leaves his hotel, " The Angel ", behind St. Clements in the Strand on the 10th October, 1786.

> " In the evening about 6 o'clock we took a coach and our baggage with us to the Bull in Bishopsgate Street—a very good INN—and there we drank TEA. For the coach to the Bull, paid 1.6. For tea, etc., at the Bull paid 0.1.9."

A cup of tea was evidently as much a part of waiting for a coach in 1786 as it is part of waiting for a train in 1952. The taxi fare from the Strand to Bishopsgate would now be about 3/6*d.*

[1–2]The State of the Poor, Sir Frederick Eden, 1797.

[3]The Diary of a Country Parson, 1758-1802, James Woodforde.

I have previously referred to the enormous meals consumed in the eighteenth century. Parson Woodforde was not a rich man but he kept a very good table. The entry for 29th February, 1788, is by no means exceptional and indeed he himself says the meal he described was prepared at three hours, notice—what we would call ' Pot luck '.

> " Feb. 29. Mr. Taswell sent early to me this morning that he would take a Family Dinner with us to-day and desired us to send to Mr. Custance that they might not wait dinner for him. He went from Weston House early this morning to go to Aylsham to read Prayers there today being Friday. At 11 o'clock this morning I sent Briton to Weston House to let them know that Mr. Taswell was to take a Family Dinner with us today, Briton returned pretty soon and informed us that Mr. and Mrs. Custance, Lady Bacon and Son and Master Taswell would also come and partake of the Family Dinner, and they sent us some Fish, a wild Duck and a Sallad. It occasioned rather a Bustle in our House but we did as well as we could—We had not a bit of White bread in house, no Tarts whatever, and this Week gave no Order whatever to my Butcher for Meat, as I killed a Pigg this Week. We soon baked some white bread and some Tartlets and made the best shift we could on the whole. About 3 o'clock Mr. and Mrs. Custance, Lady Bacon and Son, Mr. Taswell and Nephew arrived and they dined, drank Coffee, and Tea and returned home about 7 o'clock this Evening to Weston House. Mr. Taswell with his servant came here a little time before the other Company on horseback from Aylsham, he dressed himself at my House. We gave the Company for dinner some Fish and Oyster Sauce, a nice Piece of Boiled Beef, a fine Neck of Pork rosted and Apple Sauce, some hashed Turkey, Mutton Stakes, Sallad &c., a wild Duck rosted, fryed Rabbits, a plumb pudding and some Tartlets. Desert, some Olives, Nutts, Almonds and Raisins and Apples. The Whole Company were pleased with their Dinner &c. Considering we had not above 3 hours notice of their coming we did very well in that short time. All of us were rather hurried on the occasion."

It will be noted that their principal meal of the day or " Dinner " was taken about 4 o'clock in the afternoon. In the nineteenth century the time of the midday meal was advanced and afternoon tea crept in between dinner and supper. In the late nineteenth and early twentieth century it became fashionable to have dinner in the evening but, alas, dinner is shewing marked signs today of going back to the middle of the day and the lighter evening meal is again becoming fashionable under the title of supper. Afternoon tea has, however, not changed.

Drummond and Wilbraham quote two foreigners' opinions of afternoon tea in the nineteenth century :—

> " It was at this period that ' afternoon tea ', taken at about 5 o'clock began to become popular, and the bread and butter and buttered toast of England to acquire a great reputation. Here are tributes from two appreciative foreigners–
>
> ' The Butter and Tea which the Londoners live upon from morning until three or four in the afternoon, occasions the chief consumption of bread which is cut in slices, and so thin, that it does as much honour to the address of the person that cut it, as to the sharpness of the knife '[1]
>
> ' The slices of bread and butter, which they give you with your tea, are as thin as poppy-leaves—But there is another kind of bread and butter usually eaten with tea, which is toasted by the fire, and is incomparably good. This is called toast.' "[2]

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[1] A Tour to London, M. Grosley, translated by T. Nugent, 1772.

[2] A Journey to England, C. P. Moritz, 1782, cited in the British Tourist, W. Mavor, 1798/1800.

According to Drummond and Wilbraham, dinner was eaten at mid-day in the late part of the seventeenth century, and tea was again partly responsible for a change in social custom. Parson Woodforde was evidently fully in the fashion in dining at four o'clock.

> " Dinner was the chief meal of the day and was usually eaten about mid-day, although towards the end of the century there was a tendency to dine later among the class that had taken to the new custom of drinking tea, coffee, and chocolate. The introduction of these beverages had a marked effect on the habits of the leisured class who could afford to drink them, because it favoured the development of social entertainment in which both sexes could take part. They were in no small measure responsible for the alteration in the times of meal, which can be traced in the late seventeenth century and which continued in the eighteenth. A light breakfast of coffee or chocolate and rolls became fashionable, and being taken rather late, about 9 or 10 o'clock, tended to put back the dinner hour ".

My dissertation will not even approach completeness without some reference to tea in its relation to the consumption of beer and spirits. Few people cannot have seen several of Hogarth's illustration of eighteenth century life at least in the form of prints and be aware of the evil effects of the free availability of cheap spirits at that period.

The word " teetotal " is of very modern origin (about 1833) and movements concerned with total abstention and ' prohibition ' probably arose from a realisation of the very evils resulting from the drinking of cheap spirits. Until the unauthorised sale of cheap ' gin ' and raw crude spirits started in the early eighteenth century any moral or religious objection to wine and ale was probably most unusual as it is today in the wine producing countries. Some idea of the seriousness of the position in England in 1736 when Government first took action to check the evil is given by Clark in his textbook of applied pharmacology which I have quoted from previously.

> " It is difficult to say whether drug addiction is becoming a more serious problem as civilization increases in complexity. One certain rule appears to be that when a race is introduced to a powerful drug to which it is not accustomed the results are usually disastrous. The best-known example of this effect is the introduction of gin into England in the first half of the eighteenth century. During this period there was a definite check in the increase of population. This did not occur in other European countries and cannot be accounted for by general economic conditions that was then prevalent. Similar effects have frequently been produced when savage tribes have been introduced to strong spirits, and another familiar example is the introduction of opium to China "[1]

Drummond and Wilbraham give the whole sad story and shew how tea, and beer brewed under controlled conditions by reputable brewers, have helped to stamp out this social evil which caused so much misery and poverty in the eighteenth and early nineteenth century.

> " It has been estimated that the consumption of real gin, that is spirit on which duty had been paid and which was probably more or less drinkable, rose from half a million gallons in 1700 to more than five million gallons in 1735, when the authorities began to take steps to check the evil. It is impossible to form any estimate of the enormous consumption of illicit liquor, much of which was terrible stuff, distilled from any rubbish that would ferment ".

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[1] Applied Pharmacology, A. J. Clark, page 267.

Driven by a rising tide of protest to do something, the Government raised the taxation on spirits in 1736. It was a half-measure and did little more than arouse widespread wrath leading to rioting. A mob smashed the windows of the house of Sit Joseph Jekyll, who was held responsible. By the middle of the century gin-drinking was causing untold misery and ill-health and thousands of deaths. The terrible picture which Hogarth's " Gin Lane " reveals is no exaggeration in the light of what contemporary writers have said. Henry Fielding's words can be taken as an example :—

> " The drunkenness I here intend is that acquired by the strongest intoxicating liquors, and particularly by that poison called *gin*, which I have great reason to think, is the principal sustenance (if it may be so called) of more than a hundred thousand people in this metropolis. Many of these wretches there are who swallow pints of this poison, within the twenty-four hours, the dreadful effects of which I have the misfortune every day to see, and to smell too."[1]

It was in this year, 1751 ,that the authorities took more drastic measures to check the evil. Taxation was raised, this time substantially, and some efforts were made to suppress the preparation and sale of illicit spirits. It is possible to get an idea of the sort of stuff which the less reputable gin shops sold by glancing at some of the recipes which were published quite openly. Here is one, by no means one of the worst :—

Oil of vitriol (sulphuric acid)
Oil of almonds
Oil of turpentine
Spirits of wine
Lump sugar
Lime water
Rose water
Alum
Salt of Tartar.[2]

The increased taxation and the other measures did something to check the growth of the evil.

" The most dangerous form of sophistication was the addition of lead. Sometimes, as we have already said, ' sugar of lead ' was added for the purpose of sweetening a sour wine, and one book recommended the addition of a pint of good wine vinegar saturated with litharge (lead oxide) to each hogshead of wine.[3]

Lead preparations were also believed to be helpful in clearing a muddy white wine[4] The merchants claimed that no trace of metal passed into the wine but they were soon proved wrong when the first reliable chemical tests were devised[5]. It then became clear that the worst fears of Dr. Richard Mead[6], Sir George Baker, and others who had drawn attention to the grave risk of lead poisoning were justified, and that many deaths must have resulted from this cause ".

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[1] An Enquiry into the Causes of the late Increase of Robbers, etc. H. Fielding 1751.

[2] The Publican's Daily Companion, P. Boyle, (undated, probably 1794).

[3] Valuable Secrets concerning the Arts and Trades, Anonymous, 1795.

[4] The Art of Making Wines from Fruit, Flowers, and Herbs, W. Graham, 1770.

[5] Description of Portable Chest of Chemistry, J. F. A. Gottling, 1791.

[6] A Mechanical Effect of Poisons, Dr. R. Mead.

Some of the latter part of my quotation from Drummond and Wilbraham may appear somewhat irrelevant but it does serve to illustrate the necessity for, and the basis of modern food and drug regulations to which tea is also subject. The maintenance of the high quality of tea now exported from countries like Ceylon and the prevention of unfair competition from areas where adulteration is liable, are also both ensured by food and drug regulations and are actually very helpful to the producer.

By the end of the nineteenth century tea had indeed become a staple of the diet of the British people. Again Drummond & Wilbraham are my main source of information.

> "We are sorry to remark also, notwithstanding all we have so often said in favour of tea, that the use of it with bread and butter, as the almost *sole* food of the working classes in manufacturing towns, is a leading cause of the extension of scrofula among the mass of their population, and it hence becomes a question whether sobriety which the introduction of tea has promoted, compensates for the loss of vigour of constitution and power of body, which have followed its use, by that class of the community."[1]

Professor Jack Drummond himself was responsible for the discovery which completes my story. During the last war when the diet of the British people was kept under very strict survey, the diet of groups of poorer people living on a relatively poor diet was specially studied by Drummond and his co-workers.

In spite of the poor diet of the particular group, symptoms of Vitamin B2 or riboflavin deficiency were remarkably uncommon and it was obvious that the diet contained some hitherto unsuspected source of this vitamin. It was discovered that tea and beer, are both quite rich sources of this vitamin which is vitally necessary to the maintenance of good health. Vitamin B2 is vitally connected with the functioning of nervous tissue, so that far from being 'bad for the nerves,' tea actually supplies a nutrient vitally necessary for the health of nervous tissue.

Apart from its place as a stimulant beverage beloved by millions of people in all walks of life, in sickness and health, in joy and in adversity, tea is therefore, able to make its own contribution to a balanced diet.

Tea is just as, or even more popular in this 20th century of rush and tension, as it was in the leisured circles of the seventeenth and 18th centuries who delayed their midday meal the better to enjoy it. The demand for tea will go on increasing so long as its cost is commensurate with the consumer's pocket. Having dealt at length on the history of the consumption of tea in England, I must point out the lesson that history teaches us, which is that tea has all the virtues which appeal to popular needs and taste, but that its popularity is intimately connected with its low cost per cup of brew. The tea industry must ensure that it maintains this advantage over all other beverages including the most modern synthetic flavoured and aerated concoctions of caffeine.

[1] The Family Oracle of Health, Vol. II, 1824.

MODEL FACTORY MADE FROM SCRAP

By

J. Landreth

The Agricultural Section of the Colombo Plan Exhibition included a stall assigned to the tea industry and chief among the exhibits representing the Tea Research Institute was a model of the factory at St. Coombs. Built to the scale 1: 24 this model factory stood 2½ ft. high, and weighed approximately 350 lbs.

The fascination of working models is well known, and it may justifiably be claimed that the replica of our factory more than achieved its object of giving visitors a glimpse of the rather complicated process of manufacture that tea leaf must undergo before it can provide the man in the street with his daily drink. It is with some natural sense of self-satisfaction, therefore, that we look back upon this achievement, for the model factory was the result of a patient co-operative effort by several members of the Institute's Engineering Department who, in nearly every case, had to fashion their materials out of junk.

With the exception of the engines and generators, all the machines and withering fans were made from scrap iron, steel and brass. The present drier furnace verandah on St. Coombs differs from that of the model factory as the former has to accommodate experimental equipment not installed in a normal tea factory, but apart from this detail the model was reasonably accurate.

Approximately 190 feet of 3/8" square iron were used for the main structure to represent rolled steel joists. Scale model sections were not available in the U.K. and the time allowed for completion for the work did not permit the necessary machine work on the square iron. A wooden lay-out fitted with blocks was made to locate the frame structures in place for drilling and also to ensure that each frame conformed to size. Hardened steel templates and drilling jigs were used for making and drilling all corner joint pieces, but since approximately 1,200-3/32" diameter rivet holes had to be drilled in the 3/8" square iron section and corner joint pieces, the care and time necessary to make jigs and templates was well spent. When the frames were completed, these were secured to the main table by set screws, the base of the frames being drilled and tapped. The intermediate steel sections were then fitted to support the floors.

1/8" diameter stainless steel rod was used for the lineshafting and the hangers were machined from cast iron scrap and fitted with brass bushes. The delivery date given for 1/8" bore ball bearings which we had hoped to fit was several months too late.

Plywood floors were next fitted and wired for lighting, after which the bulking chamber and partitions were constructed. Teak window frames were then fitted to each bay, removed, glazed and painted and again secured permanently in place.

Tin plate was used for the roofing and cladding, the corrugations having been formed by a small rolling mill made up from scrap iron. The down-pipes and guttering were also made up from tin plate.

Rough engine castings were obtained from the U.K. and the necessary machining and fitting was carried out here. Whilst these are intended to represent

A view of the model factory set against a natural background not far from the site at which its prototype stands. Structural openings enabled sightseers to see the machinery in operation.

diesel engines, they are in fact steam engines and we ran them for some time in the workshop using compressed air. The rollers and roll breakers were fitted with 3/32" bore ball bearings.

Motive power for the factory is provided by a counter-shaft driven through reduction gears from an electric motor, the latter having been purloined from the Director's floor polisher !

Our efforts to obtain a transformer for the lighting were unsuccessful, and we eventually had to wind one here, despite the difficulty experienced in obtaining the correct gauge of copper wire for this item. Coir dust and sand sprinkled on glue and sprayed in the appropriate colours was used to represent grass and the surrounds.

The Colombo Plan Exhibition was destined to fill the interval between two tragic events in Commonwealth history—the death of His Majesty King George VI and the death of the Rt. Hon. D. S. Senanayake, Ceylon's first Prime Minister. The late Premier, to whom this Institute owes a special debt for his sober appreciation of its role in the Island's agricultural progress, visited the Tea Research Institute stall a few days before his death.

DESMODIUM OVALIFOLIUM AS A COVER CROP FOR TEA

By

I. A. Mollison

Mr. Fernando's article in the *Tea Quarterly* for June, 1951 prompts me to give a short report on the planting of *Desmodium ovalifolium* in a new clearing of tea. In 1948 Mr. C. C. Barry, Keragala Estate, Kuruwita, (Ratnapura District) planted a new clearing of 10 acres on very steep ground at a height of about 600 feet. At the same time as the tea-seed was planted, cuttings of *Desmodium ovalifolium* were put in alternate rows ; these spread rapidly and within two years formed a thick mat throughout the field. The creeper did not interfere in any way with the growth of the young plants, but gave them excellent protection especially in the drought early in 1949, when the earth beneath the creeper could be found cool and moist.

Once the Desmodium was well established, weed-growth and soil-wash were negligible, and by 1950 there was a field of strong and healthy plants with a very small percentage of losses. By comparison, in 1949 another clearing on adjacent ground was planted with *Indigofera endecaphylla* ; this had a tendency to smother the young plants, but did not check weeds effectively.

In 1950 the Desmodium was uprooted in alternate rows and forked in as green manure ; it was intended to uproot the other rows in 1951 but, the estate having been sold meanwhile, I do not know if that plan was carried out. This was intended to check any possibility of the creeper getting out of control, but I do not think it would have done so once the plants were tall and beginning to spread. In some old tea-fields on Keragala *Desmodium ovalifolium* had been planted as a cover crop, but it could not compete in anyway with a heavy cover of mature tea. Indigofera, on the other hand, could be a nuisance as it tended to grow up through the bushes.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT 10-00 A.M. ON SATURDAY, 1ST MARCH, 1952, AT THE TEA RESEARCH INSTITUTE, ST. COOMBS, TALAWAKELLE

Present.—Mr. R. C. Scott, C.B.E., (Chairman) ; Dr. A. W. Joachim, M.B.E., (Director of Agriculture) ; Mr. R. C. L. Notley (Chairman, Planters' Association of Ceylon) ; Messrs. W. Neal de Alwis, J.P., U.M., V. G. W. Ratnayake, M.B.E., M.P., D. E. Hettiarachchi, J.P., U.M., H. de T. Wilkinson Kay, Errol Jayawickreme, A. D. McLeod, W. H. Attfield and J. Lamb (Director and Secretary to the Board).

1. Notice convening the Meeting was read.

Before taking up the business of the meeting the Chairman moved a vote of condolence with the Royal Family over the death of the late King, His Majesty King George VI.

Letters and messages regretting inability to be present were received from Messrs. A. G. Ranasinha, C.M.G., C.B.E., C.C.S, (Secretary to the Treasury), G. K. Newton and W.H. Gourlay.

2. The Minutes of the Meeting of the Board held on 21st December, 1951, were confirmed.

3. **Membership of the Board & Committees**

(a) **Board**

The Chairman reported that :—

(*i*) Mr. R. M. Macintyre had resigned his seat on the Board as a representative of the Agency Section of the Planters' Association of Ceylon as from 31st January, 1952. He had since proceeded on furlough. Mr. G. K. Newton had been nominated to take his place with effect from 22nd February, 1952.

(*ii*) Mr. W. H. Gourlay replaced Mr. Roger Davies as an ex-officio member of the Board on being elected Chairman of the Agency Section of the Planters' Association of Ceylon on the 22nd February, 1952.

On behalf of the Board he thanked the retiring members for the services they had rendered to the Institute during the period of their membership. He also extended a welcome to the two new members, Messrs, G. K. Newton and W. H. Gourlay, both of whom had previously served on the Board.

(b) **Estate & Experimental Sub-Committee**

(i) Visiting Agent, St. Coombs Estate. The Chairman referred to the sudden death, which took place on 17th January, 1952, of Mr. A. H. Hall, the Visiting Agent of St. Coombs, and a member of the Estate & Experimental Sub-Committee.

The meeting passed a vote of condolence in the customary manner.

The Chairman then reported that the Estate & Experimental Sub-Committee at a meeting held on 23rd February, 1952, decided to recommend the appointment of Mr. G. K. Newton as the Visiting Agent of St. Coombs. Mr. Newton was agreeable to serve in that capacity.

The Chairman stated that if the appointment was confirmed, Mr. Newton's presence at Board meetings would be of great advantage.

The Board agreed to Mr. Newton's appointment as the Visiting Agent of St. Coombs Estate.

(*ii*) The Chairman reported that Mr. Richard Leaning o Diyagama Estate had accepted the invitation extended to him and was now a member of the Sub-Committee.

Finance

(a) Accounts of the Institute for period ending 30th November, 1951

The Chairman said that copies of these accounts had been issued to members. The St. Coombs estate working account showed a credit balance of Rs. 32,263/26. At the same date in the previous year the estate had showed a loss of Rs. 26,077/91 It was anticipated that when the final accounts for the year 1951 were closed, the profit from St. Coombs would be in the region of Rs. 68,000. Members would be interested to know that the crop harvested for the year 1951, viz., 265,146 lbs., has been the highest recorded on St. Coombs. The average yield per acre was 925 lbs. The estimated crop was 220,000 lbs.

Staff

(i) Director—Mr. J. Lamb

Mr. Lamb was due to leave Ceylon on March 5th. He would fly to Kenya to attend the formal opening of the Tea Research Institute there and then proceed to England to complete the balance of his leave. He was due back in Ceylon about the 20th May, 1952.

(ii) Plant Physiologist—Mr. G. B. Portsmouth

Mr. Portsmouth was due 8 months' leave at the end of May, 1952 and his agreement was due for renewal. Mr. Portsmouth was willing to renew the agreement.

The Board approved the leave and the renewal of Mr. Portsmouth's agreement.

(iii) Pathologist—Mr. C. A. Loos

Arrangements had been made for Mr. Loos to proceed to the United Kingdom for training at Rothamsted lasting about six months under the Commonwealth Technical Assistance Scheme. He was due to sail on the 24th April, 1952.

(iv) Mycologist—Mr. B. N. Webster

Mr. Webster arrived in Ceylon on 25th December, 1951, and assumed duties at St. Coombs from the New Year.

(v) Assistant Pathologist—Mr. G. D. Austin

Mr. Austin was now 56 years of age and was due for retirement. The Director recommended the extension of Mr. Austin's period of service up to 60 years of age. Mr. Austin was agreeable to the extension and was in possession of a medical certificate testifying to his fitness.

The meeting approved the recommendation and were of opinion that steps should be taken to train an understudy to take Mr. Austin's place when he eventually retired.

Small Holdings Advisory Service

The Chairman reported that a meeting of the Small Holdings Sub-Committee was held the previous afternoon. Ten candidates selected from a total of 61 applicants were interviewed for appointment as Tea Instructors (second batch of five).

The undermentioned Tea Instructors who were appointed in the first batch, assumed duties as from 1st January, 1952.

Messrs. D. J. Kulatunge, P. Navaratne, G. A. Mendis, T. B. Ratnayake and S. Abeyawickreme.

The Sub-Committee had also considered very fully the question of further expansion of the schemes and in view of the heavy working costs decided to recommend that the appointment of the 3rd batch of 5 Tea Instructors be deferred. They had agreed that if this recommendation was accepted the scheme would support itself for at least another 14 years or so. They also agreed to recommend that for the present the additional appointments be restricted to one mechanic/operator, and one driver for the propaganda van and a gardener.

On the proposal of Mr. Errol Jayawickreme which was seconded by Mr. A. D. McLeod, the Board unanimously approved the recommendations made and the action taken by the Sub-Committee.

(Sgd.) J. LAMB,
Secretary

Talawakelle,
25th April, 1952.

NOTICES

The Institute's Laboratories and Offices are situated at St. Coombs, Talawakelle, and all applications and enquiries should be addressed to the Director, Tea Research Institute, St. Coombs, Talawakelle.

Specimens and other consignments sent by rail should be forwarded to Talawakelle Station c/o Messrs. M. Y. Hemachandra & Co., Forwarding Agents. *Carriage should be pre-paid.*

Visitors' Days. The *second* and *last* Wednesdays in each month have been set aside as Visitors' Days at St. Coombs Estate, and also at the T. R. I. Sub-Station, Gonakelle Estate, Passara, when it is hoped anyone interested will visit the Stations.

Rules for the Occupation of St. Coombs Guest House

(1) The Guest House is normally intended for the use of persons visiting the Institute and St. Coombs Estate on business. Children can in no circumstances be accommodated.

(2) Permission to occupy a room for the night must be obtained from the Director in writing and, unless sufficient notice be given, accommodation cannot be guaranteed.

(3) All visitors must sign the Visitors' Book on arrival.

(4) A bedroom may not be occupied for more than one night if required by another visitor. This shall not apply to Members of the Board or of Committees meeting at St. Coombs who shall also be entitled to priority in the allocation of accommodation when on official business.

(5) Complaints or suggestions shall be entered in the book provided for the purpose and not made to the Guest House Staff. All payments due for services rendered shall be made in *cash* to the Guest House Keeper and a receipt obtained from him on the official form. The scale of approved charges is posted in the building. The Guest House Keeper is forbidden to give credit or to accept cheques.

(6) All breakages will be charged for at cost price.

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